AD-A142 513 SWITCHABLE ZERO ORDER DIFFRACTION GRATINGS AS LIGHT VALVES(U) MASSACHUSETTS INST OF TECH CAMBRIDGE RESEARCH LAB OF ELECTRONICS J MELNGAILIS 20 APR 84 1/1

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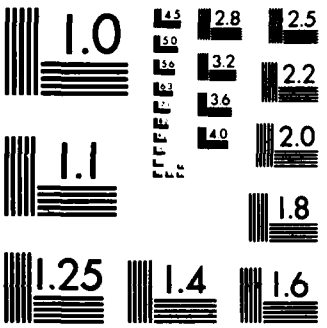

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Semiannual Report

Switchable Zero Order Diffraction Gratings as Light Valves

Office of Naval Research

Contract N00014-84-K-0073

covering the period

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Submitted by

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Background

The goal of this project is to produce a light valve based on the principle of the cancellation of the zero order of diffraction. The light valve works by the displacement of two facing aligned phase gratings with respect to one another by half of a grating period. The light valve is to be simple and mass producible into matrix addressable arrays. Such arrays would serve as displays or as spatial light modulators in optical signal processing.

The material we have chosen to fabricate such valves is polyvinylidine fluoride (PVF_2). It is transparent to visible light and is also strongly piezoelectric. The piezoelectricity would be exploited to produce the motion. On the basis of our previous research we have chosen to fabricate the gratings by embossing and to produce the motion using a chevron geometry which amplifies the motion created by the piezoelectricity.

Progress in the Half Year:

a) Embossing

Using techniques developed previously 3.8μm period 0.25 to 1.5μm deep grating templates were produced. The profile in the nickel template was verified by electron microscopy to be close to square wave. These templates were then used to emboss several series of samples. For example, in one series 32 samples were pressed at temperatures of 60 and 70°C at pressures between 30,000 and 60,000 psi. Sample curling after embossing could be minimized by permitting the PVF_2 to cool in contact with the mold. The normal incidence transmission spectra of the gratings was measured. The expected $\cos^2(\pi(n-1)a/\lambda)$ dependence was observed. From the position of the

minimum as a function of wavelength, λ, the depth of the grating, a, was inferred since the index n is known. Variation in depth as a function of embossing pressure was observed. For example, gratings embossed at 67°C and 30,000 psi had a depth 0.35μm while those embossed at 50,000 and 60,000 psi were 0.5μm deep. The grating on the nickel master was measured in preliminary fashion to be 0.65μm ± 0.1μm deep. A more accurate, destructive, measurement will be made by sectioning the grating and examining the profile with a scanning electron microscope.

b) Motion Produced by Piezoelectricity

The mask designed and fabricated to test the chevron motion producing scheme has been used to pattern metal on poled PVF_2 films 9μm thick. To fabricate the chevrons a number of new techniques needed to be developed:

1. Lithography (resist spinning, exposure and development) on 9μm thick PVF_2 membranes, which has the consistency of "Saran Wrap". Present technology is designed for rigid wafers or glass plates.

2. Reactive-ion etching to perforate the membranes in the desired pattern.

3. Transfer of the perforated (delicate) membranes from the lithography jig to the measuring fixture.

4. Microgluing of the fixed part of the membranes to the mating surface of the measuring jig.

The first two fabrication steps have been achieved by mounting the PVF_2 sample on an aluminum substrate using diffusion pump oil. A transfer

technique which depends on attaching the membrane to a frame has been tried and found to work. As for the last step, various microgluing schemes are currently being tried.

c) An electrostatic motion scheme based on attraction and repulsion of interdigitated electrodes is being pursued at a lesser pace as an alternate scheme. Several structures have been fabricated on quartz substrates with a new mask. These structures consist of interdigitated electrodes covered by a sputtered film of SiO_2 and will serve as the fixed members. For the moveable part mylar film has been selected. Ultrathin quartz had been tried in an earlier experiment and found to be unsatisfactory. The fabrication on mylar is similar to that on PVF_2, described above, and interdigitated electrodes on mylar have been fabricated.

Thus, the work in this reporting period has concentrated on development of fabrication techniques and on the execution of some of the fabrication steps. The future effort will concentrate on demonstrating the chevron motion producing scheme and on integrating the embossed grating with the chevron structure.

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